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Evaluation of glycated hemoglobin (HbA1C) as a predictor of dyslipidemia in type 2 diabetic patients

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Abstract

Aim: Patients with type 2 diabetes mellitus have an increased prevalence of dyslipidemia and are easy targets for cardiovascular diseases. This retrospective study investigated the serum lipid profile of patients with type 2 diabetes mellitus and assessed the relationship between HbA1c levels, lipid profile, and BMI to evaluate the importance of HbA1c as a predictor of dyslipidemia.

Material and Methods: The study was conducted at the Diabetes Center of the Tertiary Care Hospital in Arar, Saudi Arabia. Demographic and biochemical data of 100 patients with type 2 diabetes were collected from electronic records of the hospital. Correlation analysis was performed to analyze the association between HbA1c, lipid profile and BMI.

Results: The results revealed an increase in the levels of fasting blood glucose, blood urea nitrogen, total protein and HbA1C levels, accompanied by a decrease in albumin levels among both male and female patients with no significant difference among the genders. The study also demonstrated an alteration in the lipid profile of the patients with elevated levels of total cholesterol, TAGs and LDL-C with a concomitant reduction in HDL-C levels. Correlation analysis demonstrated a significant ($p<0.05$) positive correlation between HbA1C and different lipids (total cholesterol, Triglyceride and LDL-C) and BMI. A significant ($p<0.05$) negative correlation was found between HbA1C and HDL-C levels.

Discussion: The results indicate that in addition to as a biomarker for glycemic control, HbA1c can also be used in predicting dyslipidemia associated with type 2 diabetes to prevent the development of cardiovascular diseases.

Keywords

Type 2 Diabetes Mellitus, Dyslipidemia, Glycated Hemoglobin, Cardiovascular Diseases

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Introduction

Diabetes Mellitus (DM) is the most common endocrine disease characterized by metabolic abnormalities and long-term complications involving the eyes, kidneys, nerves and blood vessels. The disease is spreading at an alarming rate in both developed and developing countries. More than 451 million people worldwide were reported to be affected in 2017, and it is expected to reach 693 million by 2045 [1]. Such a dramatic increase will have a significant impact on the meager health resources of the developing countries, as diabetes is a chronic disease with devastating complications.

Glycated hemoglobin (HbA1c) is the most reliable marker, which is routinely utilized for monitoring glycemic control. It may be used to assess changes in metabolic control that follow an alteration in treatment [2]. Dyslipidemia is a common complication among DM patients and may be a predictor of diabetes. Patients with insulin resistance often show elevated cholesterol levels, even before they have developed full-blown diabetes. Dyslipidemia is associated with a high body mass index, and this has increased emphasis on other risk factors for cardiovascular disease such as high blood pressure. Coronary artery disease, especially myocardial infarction, is the leading cause of morbidity and mortality worldwide [3]. There is a link between hyperglycemia and atherosclerosis in type-2 diabetes mellitus (T2DM), and therefore, the management of hyperglycemia with a reduced level of HbA1c is likely to decrease the danger of extreme complications [4].

The prevalence and incidence rates of diabetes are increasing in Saudi Arabia [5]. The trend towards urbanization and lifestyle changes (unhealthy eating habits and declined level of physical activity) over the past four decades are responsible for a dramatic increase in diabetes prevalence [5]. Keeping in perspective the growing incidence of T2DM, this study was undertaken to evaluate the serum lipid profile of patients with T2DM and to find out the possible relationship between HbA1c levels, lipid profile and BMI to evaluate the importance of HbA1c as a predictor of dyslipidemia.

Material and Methods

Study Participants

This retrospective study was conducted at the Diabetes Center of the Tertiary Care Hospital in Arar, Saudi Arabia. Data of 100 patients diagnosed with type 2 diabetes mellitus was collected from the electronic records of the hospital. Files of patients suffering from any other metabolic disease or disorder other than Type-2 Diabetes Mellitus were excluded from the study. Approval was obtained from the Director of the diabetes center before collecting the data. Privacy and confidentiality of the obtained data had been insured.

Plasma glucose values for diagnosing diabetes were identified in accordance with the 2019 criteria of the American Diabetes Association [6]. Diabetes was defined as fasting plasma glucose ≥ 7.0 mmol/L or HbA1c ≥ 6.5%. Hyperlipidemia was defined as total cholesterol ≥ 5.2 mmol/L or triglyceride TG ≥ 1.70 mmol/L or low-density lipoprotein cholesterol (LDL-C) ≥ 3.4 mmol/L or High-Density Lipoprotein-Cholesterol (HDL-C) < 0.91 mmol/L.

Laboratory Measurements

Anthropometric data were collected. Body mass index (BMI) was calculated as weight/height^2 (kg/m^2). All blood samples were obtained in the morning (8 a.m.) after a 10- to 12-h overnight fast and then centrifuged (3,000 × g for 5 min) for serum separation when applicable. The level of HbA1c was determined with whole blood, while other parameters were tested with serum. HbA1c levels were determined by high-performance liquid chromatography using Arkray HA-8160 analyzers (Arkray, Japan). Serum levels of fasting glucose were tested using the glucose oxidase/peroxidase method in Abbott C16000 analyzers (Abbott, America). Albumin, total protein, blood urea nitrogen, total cholesterol, triglycerides, LDL-C and HDL-C were measured using Abbott C16000 analyzers (Abbott, America).

Statistical Analysis

Results are expressed as means ± SD. The significance of differences between the means was carried out using Students t-test. P-values <0.05 were considered significant. The correlation/association between various parameters was determined using Pearson's correlation coefficient (r).

Results

Among the 100 participants, 50 were males and 50 were females. The mean age of male participants was 62.52 ± 9.38 years with an age range of 40-77 years and the mean age of female participants was 54.44 ± 10.39 years with an age range of 33-77 years. The mean BMI of males was 31.33 ± 5.56 kg/m2 and females 29.75 ± 4.14 kg/m2.

Biochemical characteristics of the study population are shown in Table 1. There was an increase in the levels of fasting blood glucose, blood urea nitrogen, total protein and HbA1C levels accompanied by a decrease in albumin levels from normal value among both male and female patients with no significant difference among the genders. The main finding of the study was an alteration in the lipid profile of the patients demonstrating elevated levels of total cholesterol, TAGs and LDL-C from the normal values with a concomitant reduction in HDL-C levels.

Correlation analysis was performed to analyze the association between HbA1c and lipid profile (Table 2). A significant ($p<0.05$) positive correlation was observed between HbA1C and different lipids (total cholesterol, Triglyceride and LDL-C). A significant ($p<0.05$) negative correlation was found between HbA1C and HDL-C levels. Correlation analysis also demonstrated a significant ($p<0.05$) positive correlation between HbA1c and the BMI of the study population (Figure 1).

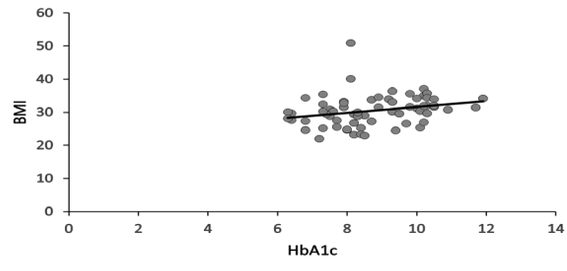

Figure 1. Correlation between HbA1C and BMI in T2DM patients (r= 0.248, p<0.05)

Biochemical parameters	Males (n=50)	Females (n=50)	Reference range	P value
	Mean ± SD	Mean ± SD		
Fasting glucose (mmol/l)	10.85 ± 5.90	9.47 ± 2.13	4.04.2007	p>0.05
Blood Urea Nitrogen (mmol/l)	7.37 ± 1.54	6.97 ± 1.17	2.5-6.4	p>0.05
Total protein (g/L)	85.10 ± 5.77	85.35 ± 3.09	64-82	p>0.05
Albumin (g/dL)	31.79 ± 3.98	32.47 ± 2.63	34-50	p>0.05
HbA1c (%)	8.54 ± 1.22	9.10 ± 1.49	4.5-6.5	p>0.05
Total Cholesterol (mmol/l)	5.99 ± 0.85	5.65 ± 0.55	1.3-5.2	p>0.05
LDL-C (mmol/l)	4.33 ± 0.84	3.97 ± 0.73	1.7-3.4	p>0.05
Triglycerides (mmol/l)	2.87 ± 0.64	2.78 ± 0.62	0.4-1.7	p>0.05
HDL-C (mmol/l)	0.60 ± 0.23	0.57 ± 0.22	0.91-2.59	p>0.05

LDL-C: Low-Density Lipoprotein-Cholesterol, HDL-C: High-Density Lipoprotein-Cholesterol

Table 1. Serum biochemical parameters among male and female type 2 DM patients

	HbA1c	
	r	p
Total Cholesterol	0.420	<0.05
Triglycerides	0.299	<0.05
LDL-C	0.564	<0.05
HDL-C	-0.262	<0.05

LDL-C: Low-Density Lipoprotein-Cholesterol, HDL-C: High=Density Lipoprotein-Cholesterol

Table 2. Correlation between HbA1c and different lipids in Type 2 diabetic patients

Discussion

The burden of cardiovascular disease (CVD), the major cause of morbidity and mortality around the world, is particularly high among patients with type 2 diabetes mellitus (T2DM). This may be partially explained by the lipoprotein abnormalities associated with diabetes mellitus. The management of diabetic dyslipidemia, may be helpful in the multifactorial approach to prevent CVD in individuals with type 2 diabetes.

Glycosylated hemoglobin (HbA1c) is the most widely used and reliable marker for the assessment of chronic glycemia [7]. The HbA1c reflects the overall blood glucose levels over a period of 2-3 months and may be used to assess changes in metabolic control that follow an alteration in treatment. In the present investigation, all the patients showed significantly elevated levels of HbA1c in blood. This was in agreement with Murugan [8] who reported that there was a strong relationship between fasting blood sugar level, postprandial blood sugar level and HbA1c level in diabetic patients.

The result of the present study showed that all diabetic subjects had higher fasting blood glucose and total protein level, while albumin level was slightly below normal in the diabetic patients. Patients were also found to have higher blood urea than normal. All these biochemical changes may be attributed to the decreased renal function in these patients.

Abnormal lipid profile is very frequently observed in T2DM patients and this may be due to insulin resistance leading to increased release of free fatty acids from fatty tissue, impaired insulin-dependent muscle uptake of free fatty acids and increased fatty acid release to the hepatic tissue [9]. All these events have been closely associated with diabetic dyslipidemia, hypertension and a high risk for cardiovascular diseases [10]. High blood glucose levels cause glycation of apolipoproteins and obstruct the normal pathway of lipoprotein metabolism [11]. In the present study, the results showed that all diabetic subjects had elevated total cholesterol, TAG and LDL-C levels and reduced levels of HDL-C. Lipoprotein lipase is an insulin-dependent enzyme, which together with insulin resistance leads to an increase in TAG levels, resulting in type-2 diabetes having high levels of TAG, HDL levels may be further reduced in DM due to elevated hepatic lipase activity that catalyzes HDL [12]. In the present study, a highly positive significant correlation was observed between HbA1c and Lipid profiles (total cholesterol, Triglycerides and LDL-C) and a significant negative correlation was observed between HbA1c and HDL-C, which was in agreement with Khan et al. [13] who stated that HbA1c exhibited direct correlations with cholesterol, TAG and LDL and reverse correlation with HDL. It has been shown that HbA1c value of <7.0% minimizes the risk of cardiovascular diseases and a value >7.0% leads to dyslipidemia in patients [14]. The present study also demonstrated a significant affirmative correlation between HbA1c and BMI, which is in concordance with another study carried out on the Western Indian population, showing that the dyslipidemic obese subjects had a significant linear association with HbA1c in T2DM subjects [15].

Conclusion

The study concludes that HbA1c can be used not only as a biomarker for glycemic control, but also to predict dyslipidemia associated with type 2 diabetes to prevent the development of CVD. Furthermore, no significant differences were observed between sex and HbA1c with respect to lipid profile suggesting the reliability of HbA1c for predicting dyslipidemia irrespective of patient's gender.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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